| Lawrence Berkeley National Laboratory | Cat Code<br>AL4041 | ENGINEERING NOTE | Serial #<br>10211 | Rev<br>A | Page<br>1 of 7 |
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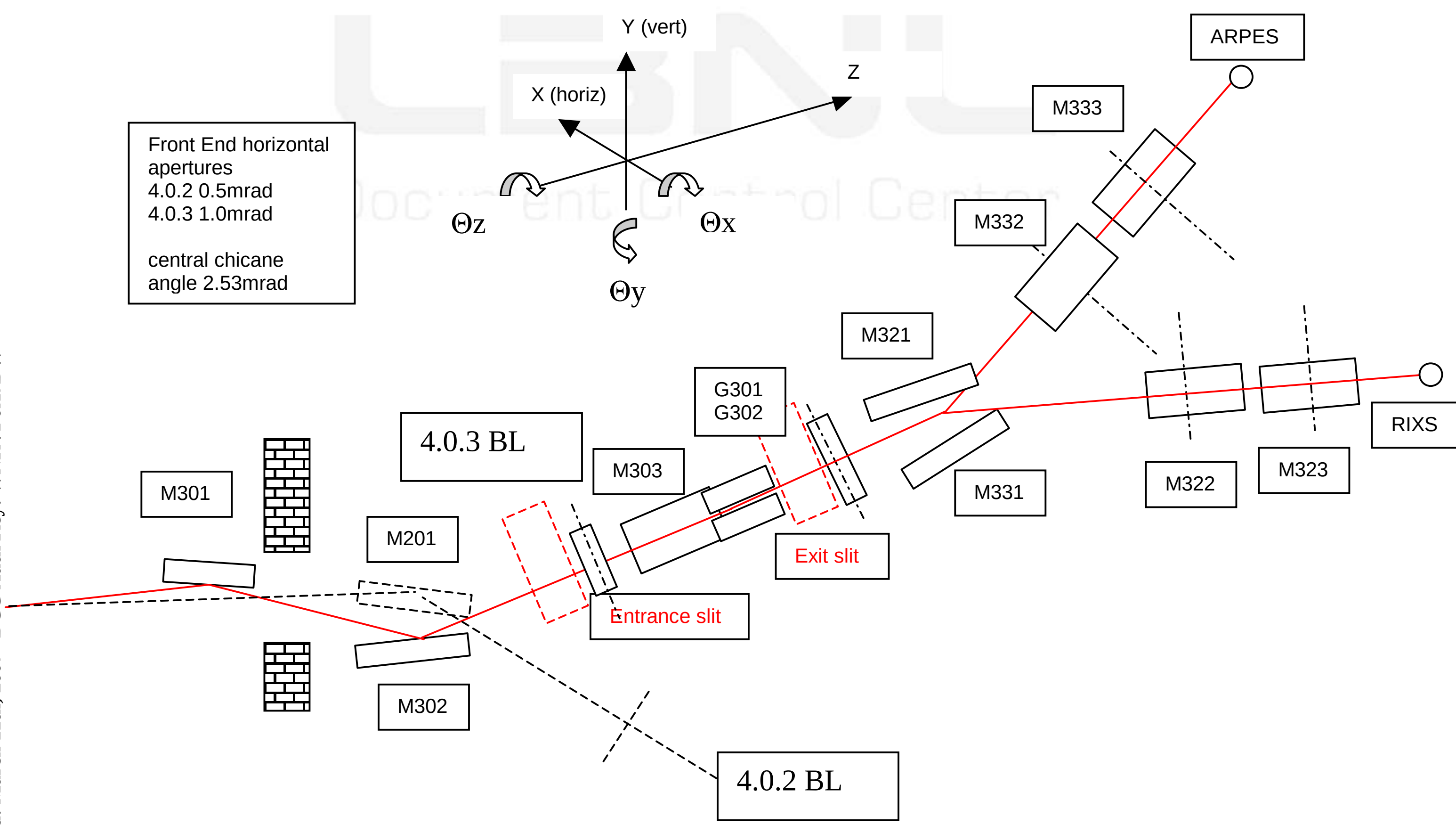
| Title<br>ALS –INSERTION BEVICE BEAMLINES<br>BL 4.0.3 – BEAMLINE GENERAL<br>MERLIN ENTRANCE AND EXIT SLIT DESIGN AND ANALYSIS SUMMARY | | | | | |

## 1. SUMMARY

This note gives an overall summary of the specifications, design, and analysis that has been completed for the MERLIN entrance and exit slit design. If more detailed information on specific components and/or analysis exists, links to databases where the electronic versions of these documents exist will be provided. The high level models can be found in the WorkManager database using the unique ID number AL-0024-3556 (entrance slit assembly) and AL-0024-6070 (exit slit assembly) and many documents relating to MERLIN can be found at the LBL eRooms site under MERLIN BL PROJECT.

The following figure gives the overall location of the slits and their relative location along the beamline. The slits are a fixed distance apart (7.7 m) while the monochromator translates up to 1.3 meters in order to meet the Rowland circle condition at the exit slit depending on the energy level selected by the user. Distances between other components and specifications for each optic can be found in the MERLIN optics summary document[1].



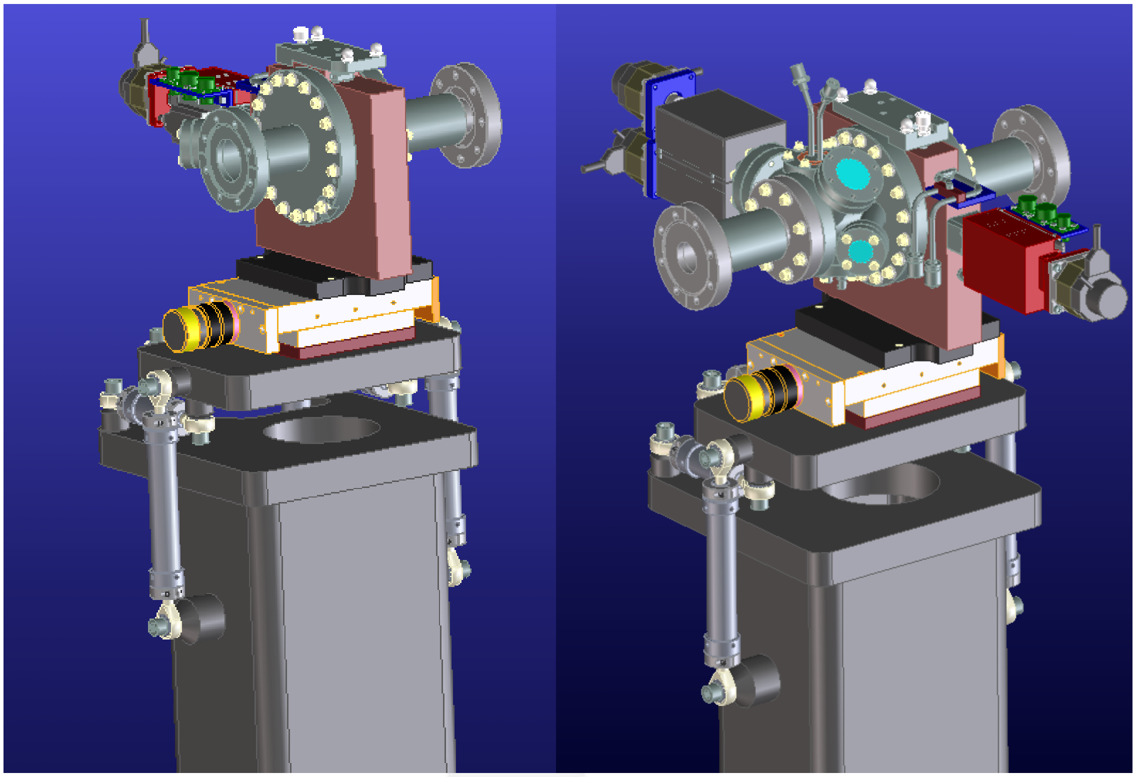


Figure 1: Entrance (left) and exit (right) slits with the beam entering from left side of picture.

## 2. DESIGN SPECIFICATIONS AND REQUIREMENTS FOR MAJOR COMPONENTS

### 2.1. Vertically defining slits

A structural analysis of the OFE Copper flexure plate[2] shows that a maximum stress of 26 kpsi is reached in a flexure joint when the actuator block is displaced by 0.125mm. With a 50 um blade overlap, the aperture opening will be 219 um, slightly greater than the 200 um opening specified in *Merlin_optics_summary_1*. Hard stops limiting the actuator block displacement to .2 mm are needed to avoid exceeding the tensile yield strength of the material (39.9 kpsi for OFE C10100/10200, H04 Temper, 1” referenced from matweb.com). This flexure design has been used in several beamlines including 11.0.1 (OFE Copper) and 8.0 (Glidcop AL-15).

Both the entrance and exit slit assemblies utilize the identical design (but rotated 180 degrees around the y-axis) for the vertically defining apertures. A FEA analysis[3] showed that the specification of < 1 micron displacement was achievable using tungsten blades with the full beam (at 55eV, 17W absorbed, 220W/mm$^{\wedge 2}$) normal to the surface of one blade. This is the worst case scenario and in practice will never be reached as in order to minimize extraneous reflections from entering the monochromator, there is a 4° chamfer lead-in to the entrance slit opening.

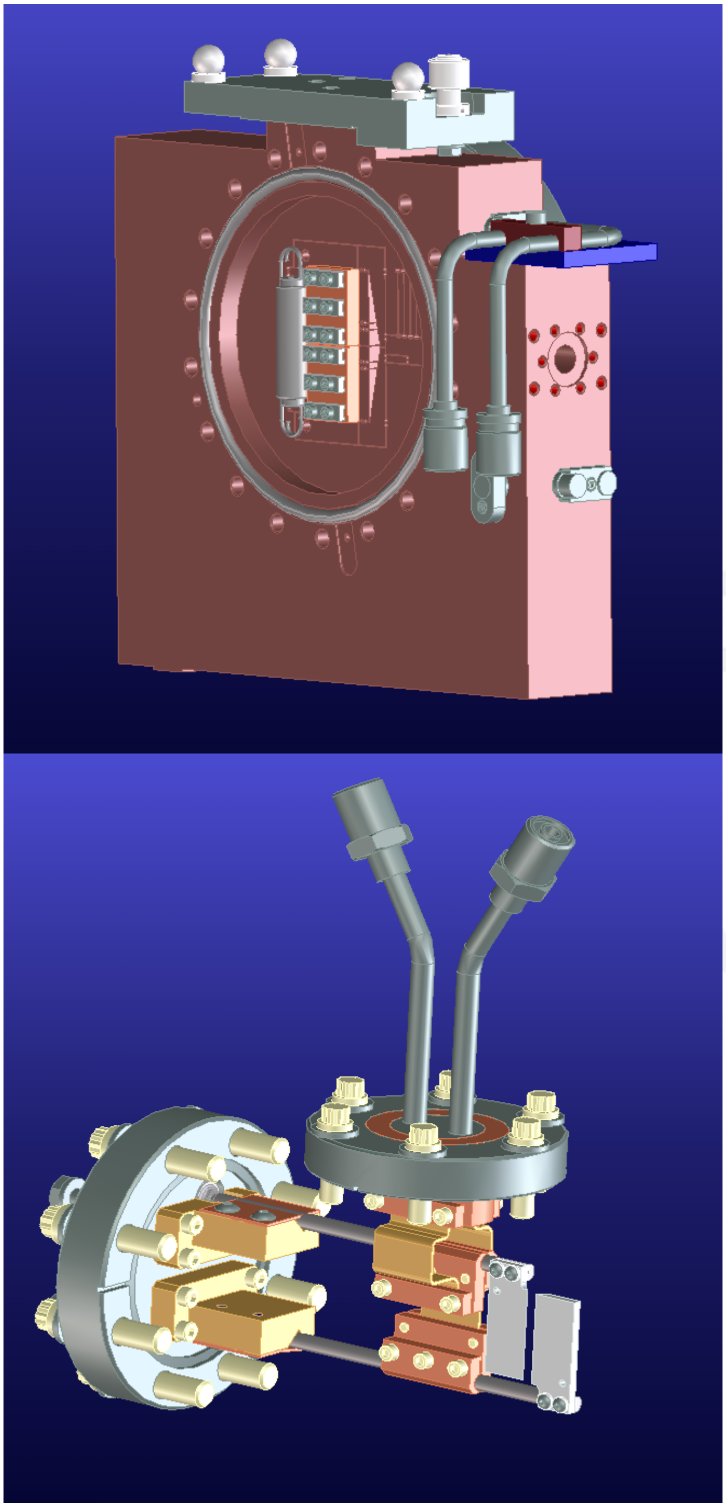


Figure 2: Vertically defining slits with cooled copper flexure (top, entrance and exit slit) and horizontally defining slit (bottom, exit slit only) assemblies.

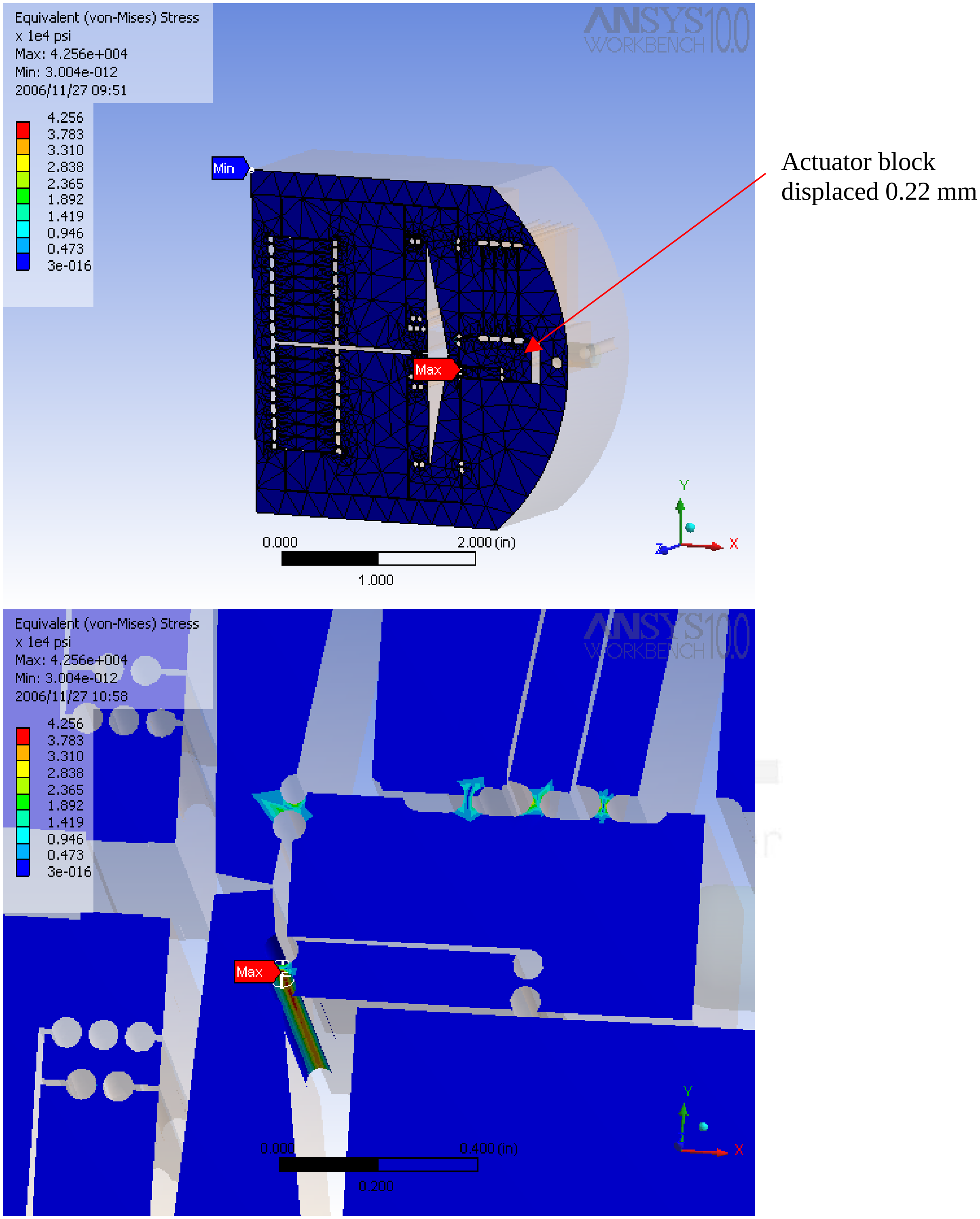
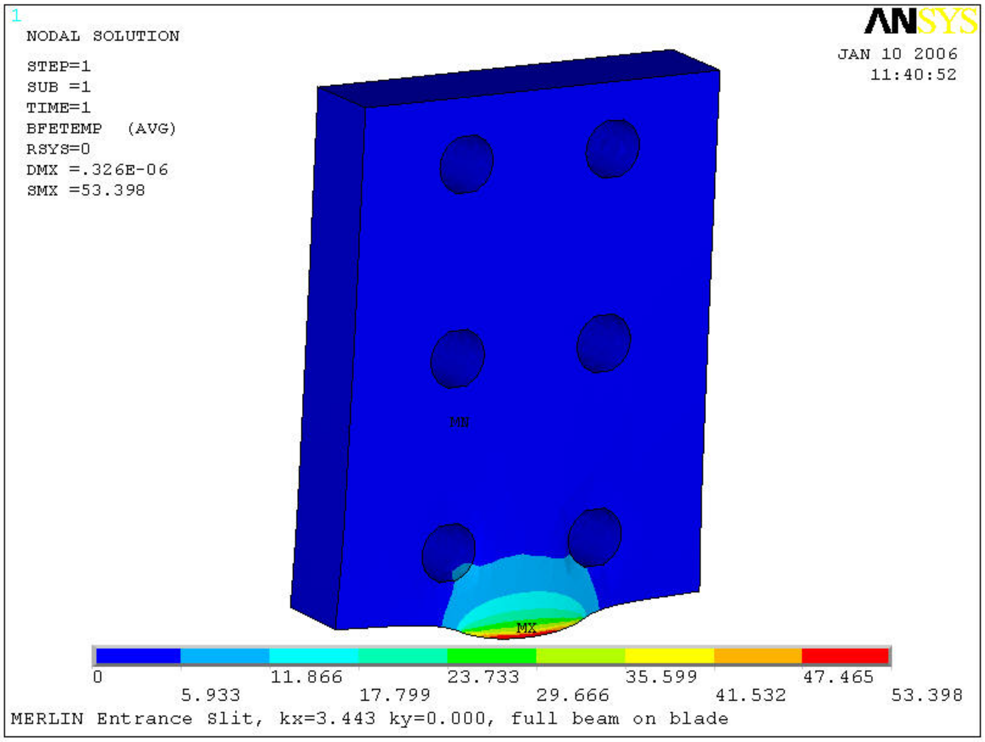



Figure 3: Analysis of flexure shows stress levels of ~43kpsi (exceeding yield stress of OFE Copper) when actuator block displaced by 0.225 mm (slit opening 310 microns).



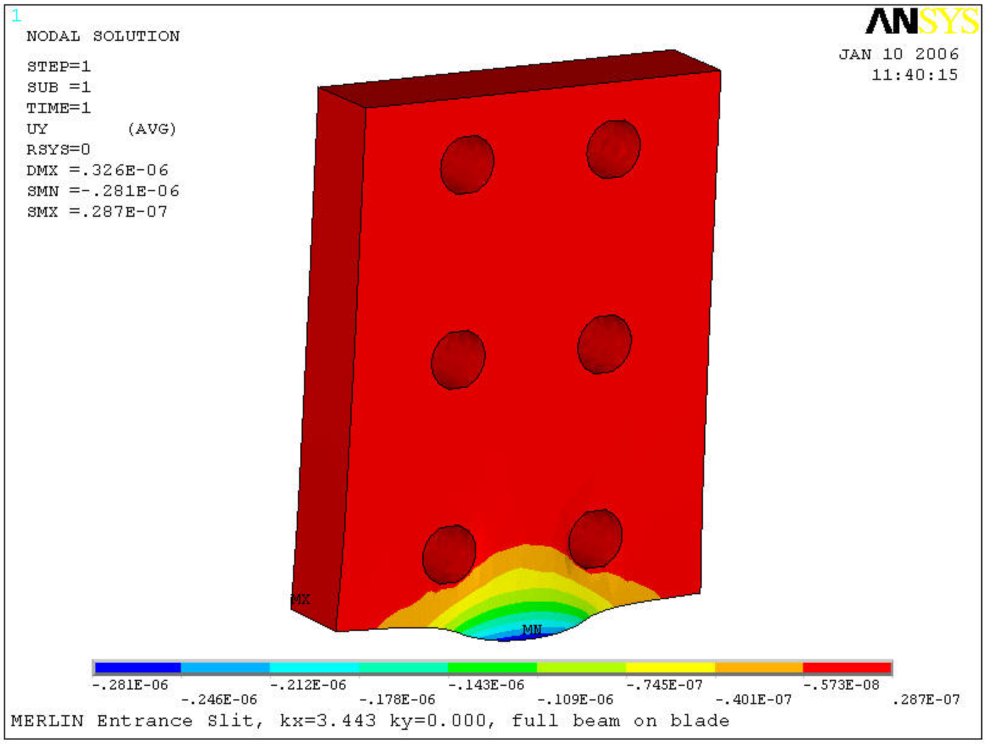




Figure 4: These figures show a maximum temperature rise of 53° C (top) and a .29 micron displacement (bottom) with a 55eV, horizontally polarized beam normal to the tungsten blade (defining the vertical slit opening).

2.2. Horizontally defining slits

Located on the exit slit assembly only, these slits will be used for calibrating and defining the beam location and width. An analysis[4] showed cooling was necessary to maintain the blades' position when the beam is incident upon a face (e.g. during beam L/R steering alignment). In order to minimize thermally-induced expansion and the resulting impact on components downstream, the rods supporting the slits are made from INVAR.

2.3. Slit stands

The specification for the entrance slit calls for a tolerance of 5 microns in elevation over a 4 hour period (*MERLIN optics summary_1)*. Temperature variations in sector 4 were shown to +/-1°C over a 12 hour period[5]; with an unfilled, 1.5m tall steel stand, this corresponds to a 12 micron expansion. When using a 10 micron entrance slit opening, the throughput drops by an order of magnitude with a 12 micron offset[6]. To mitigate this change, the entrance slit will be inside the monochromator enclosure (which may be at an elevated and stable temperature) and the stand itself insulated. If necessary, circulating heated water through the stand is an option with the current stand. If further changes are necessary, carbon fiber stands with a zero CTE could be purchased/fabricated to replace the steel pillars. The impact of elevation change on the exit stand is of less concern as the impact is minimal (e.g. a 1.26 meV shift with a 12 micron change in elevation).

3. SAFETY CONSIDERATIONS

3.1. Electrical

3.1.1. Translation stages – 24 VDC stepper motors, standard ALS component

3.1.2. Diagnostic slits – 300VDC with microamp current

3.2. Seismic - Full analysis can be found in[7],

| Description | Total Weight W, (lbs.) | Height H, (in.) | Distance D, (in.) | Number of Anchors | Anchor Size/Type (Dia, in.) | Tension Load Allowable per Anchor (lbs.) | Shear Load Allowable per Anchor (lbs.) | Safety Factor |
|---|---|---|---|---|---|---|---|---|
| M302 | 600 | 33.8 | 10.0 | 4 | .5 HDI | 2374 | 1798 | 2.8 |

3.3. Liquid-cooled components

3.3.1. Flexure plate – no joints in vacuum environment

3.3.2. Horizontal slits – no joints in vacuum environment

3.4. Cryogenic components – none

3.5. Thin Windows – none

3.6. Viewports > 15 cm - none

All files found in https://eroom2.lbl.gov/eRoom > MERLIN BL PROJECT > SPECIFICATION_AND_DESIGN_DOCUMENTS > … unless otherwise specified

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[1] GENERAL_DOCUMENTS > MERLIN optics summary_1.doc
[2] BL_COMPONENT_DATA > ENTRANCE-EXIT_SLIT_ASSY > OFE_Flexure_with_stress.dsdb
[3] BL_COMPONENT_DATA > ENTRANCE-EXIT_SLIT_ASSY > MERLIN_Entry_Slit_analysis.doc
[4] BL_COMPONENT_DATA > ENTRANCE-EXIT_SLIT_ASSY > blade_assy
[5] BL_COMPONENT_DATA > ENTRANCE-EXIT_SLIT_ASSY > Temperature_variations_report.doc
[6] BL_COMPONENT_DATA > ENTRANCE-EXIT_SLIT_ASSY > Thermal_Effect_Stands_110106.doc
[7] GENERAL_DOCUMENTS > MERLIN_SeismicCalcs-2.xls